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THE FERNSEH STANDARDS CONVERTER: VISIT TO ROME AND DARMSTADT 16th - 19th JULY 1962

Report No. A-074

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1. INTRODUCTION

Fernseh G.m.b.H. make a standards converter capable of conversion between European and American television standards, which have field frequencies differing by 10 c/s. An earlier visit to Rome[1] was made to see the first model of this converter, which was being operated by C.B.S. during the Olympic Games. At that time it was impossible to perform any tests, or to do more than watch conversion of programmes in progress. This report describes the design and performance of a later model of the converter, which is installed at the R.A.I. Television Productions Centre in Rome. Section 5 reports on further technical discussions with Fernseh engineers in their laboratories at Darmstadt.

The tests in Rome were conducted on 16th and 17th July 1962 and the discussion with Fernseh engineers took place on 19th July.

As far as possible the performance of the converter was measured objectively using pre-recorded test signals which could also be applied to the standards converters installed at Television Centre. Subjective comments on picture quality obtained by converting local studio pictures are also included in appropriate sections of the report.

2. GENERAL DESCRIPTION

The Fernseh standards conversion equipment uses a conventional image transfer system to carry out conversions between any combination of the four principal scanning standards. The equipment in Rome was, however, limited to conversion between the 525- and 625-line standards. The incoming signal is displayed on a small cathode ray tube with a Willemite phosphor and this picture is viewed by an R.C.A. one inch vidicon type 7735A. The output from the camera then passes through a.g.c. circuits which remove most of the flicker which is present in the camera output. These circuits control the amplitude of the signal by measuring a reference stripe on the left-hand side of the picture and adjusting the gain of the system so as to make the signal derived from this stripe constant in amplitude.

The general form of the standards converter is shown in Fig. 1. The first cubicle on the right contains the input picture and waveform monitors together with the line-flywheel synchronizing circuits and test signal generators. Four test signals, black-level, white-level, line-staircase and a line-locked 5 Mc/s sine-wave are provided. There are controls for setting gain and black-level which affect both the

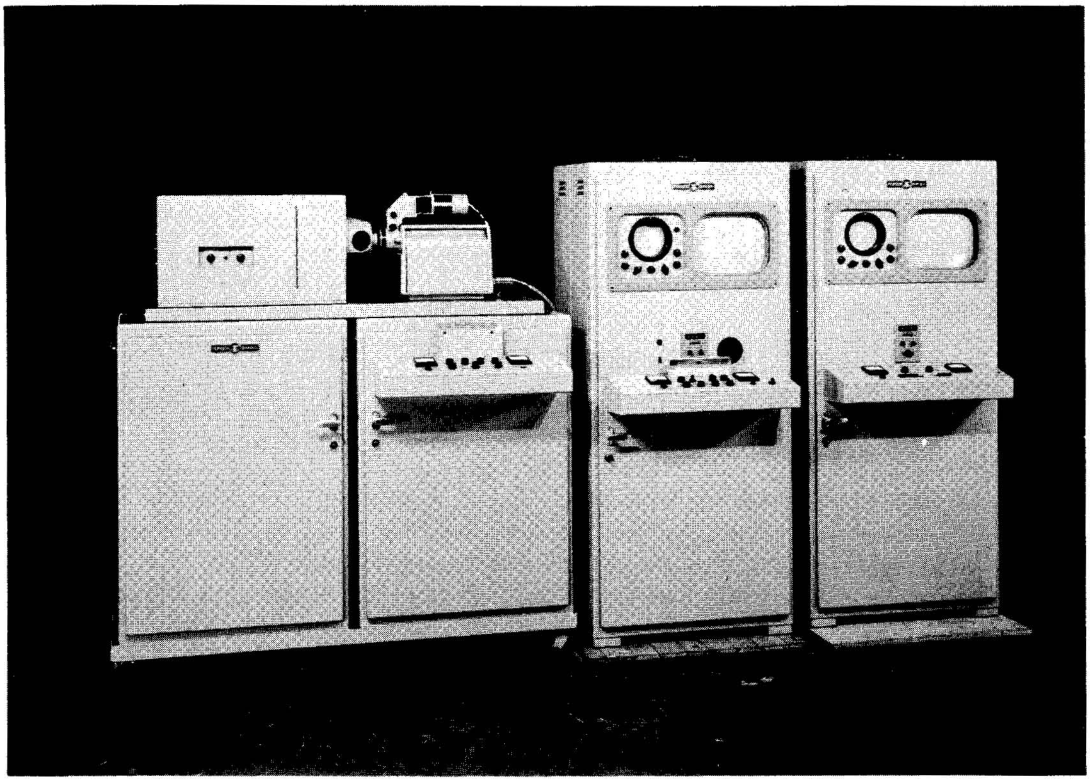

Fig. 1 - General view of equipment

test signals and the incoming waveform. A black level control circuit holds the darkest part of the incoming picture or the incoming blanking-level at the selected level. A further circuit automatically adjusts the gain of the input amplifier so that peak-white corresponds with the alignment level.

If required these circuits may be switched out, in which case the input to the cathode-ray tube is a conventional amplifier. No gamma correction is provided and the signal fed to the cathode-ray tube contains only the aperture correction necessary to correct for losses within the display.

The heart of the converter is the cathode-ray tube and vidicon camera which are mounted on the pedestal shown on the left. This pedestal contains the e.h.t. and reference pulse generators together with the scanning, focus and operational display controls. The cathode-ray tube has a fine-grain Willemite phosphor with an afterglow time constant of about 8 ms. It is capable of a peak-white luminance in excess of 2000 foot-lamberts. A normal studio lens (Xenon f/2·8) operating at f/4 is used to produce a high brightness picture on the target of the vidicon. The vidicon is operated with a wall anode potential of 750 volts and parabolic correction waveforms are applied to the first anode, to the cathode, and to the separate dynamic-focus coil. Output picture and waveform monitors, flicker correction circuits and the camera control unit are housed in the centre cubicle. The control panel on this cubicle contains those controls which are needed to ensure satisfactory day-to-day operation of the vidicon camera.

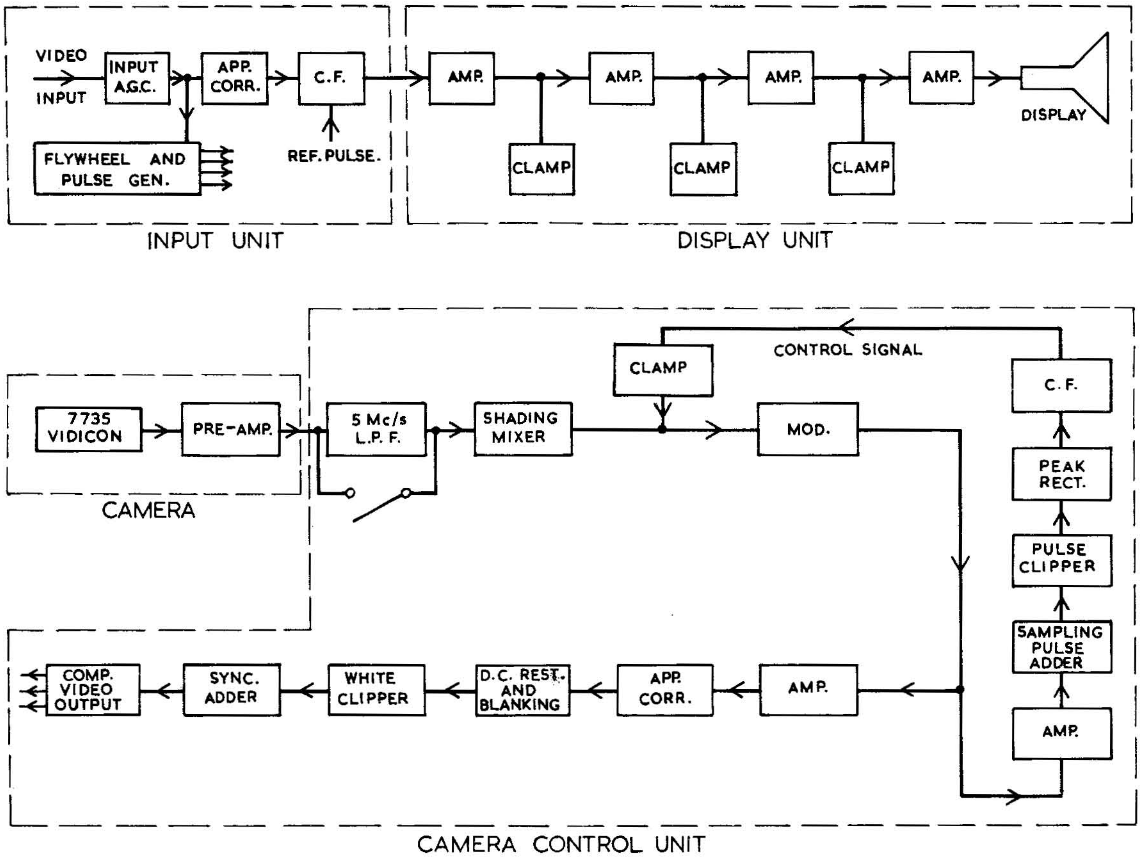

Fig. 2 - Block diagram of video circuits

3. COMMENTS ON THE DESIGN

Although the Fernseh converter is basically a combination of a telerecording display designed several years ago and a modern studio camera, great attention has been paid to the special requirements of standards conversion in bringing the two parts together. The built-in test signals, input and output monitoring, current meters, photo-cell for measuring displayed black and white level and camera dioscope, all help to make the converter alignment simple and precise.

Fig. 2 shows a block schematic of the video circuits. No provision is made for equalization or bandwidth restriction of the incoming signal and these facilities must be provided elsewhere. Most of the circuits are efficiently and economically designed although in some places, such as the display video amplifier, the design is unnecessarily complex. The inclusion of such features as automatic black level, signal level control, and the output peak-white clipper are presumably intended to simplify the job of the operator but these at times could produce disturbances to the picture. It was noticed that "drop outs" in the videotape signal caused the input a.g.c. circuit to alter the input signal level. This is undesirable but this circuit can be switched out if required.

The electron-optical alignment of the display is adjusted by direct currents passed through small coils near the electron-gun. The design of the components is such that no other adjustments are required.

The mechanical design of the converter is extremely sound and robust and accessibility is very satisfactory; servicing is further improved by the provision of door-operated internal-lights. The various operational controls are grouped in a number of control panels distributed around the three main units. If the three main units are suitably positioned with respect to each other operation of the converter is not too difficult but if this is not possible then some routine adjustments need two operators.

The cathode-ray tube has been specially designed by Fernseh for use in the standards converter and cannot be obtained from any other manufacturer.

4. PERFORMANCE

4.1. Conditions of Tests

Throughout the tests the converter was adjusted by Signor Zaccarian who is responsible for converter operations and spent a period with Fernseh in Darmstadt studying the converter before its installation in Rome. Signals were derived from Ampex tape and replayed on an Ampex 1000 C videotape machine. For both 625- and 525-line operation these machines were locked to a crystal controlled waveform. Except for the special tests mentioned under "Asynchronous Operations" the mains supply to all sections of the converter was of the same frequency as the nominal field frequency of the television signals.

The alignment of the converter was carried out according to Signor Zaccarian's interpretation of the Fernseh operating procedure and this included the following conditions:

(a) c.r.t. beam current black: 7μA;

(b) c.r.t. beam current peak white: 150μA;

(c) iris setting: f/4;

(d) camera output current: 0·3 μA;

(e) vidicon target potential: 30 V;

(f) reference pulse amplitude: 70% peak white;

(g) equalization set for uniform response to 400 lines per picture height using local R.A.I. resolution chart.

4.2. Grey Scale Rendition

On those occasions when the equipment was imperfectly aligned excessive black and white crushing was present. It was however, quite easy to align the equipment so that it only contained a minor amount of black crushing and under these conditions it appeared to operate stably and give a good converted picture. Since vignetting and other distortions from vidicons etc. can obscure measurements of the grey scale linearity, tests were also made using a field sawtooth. In this case the a.g.c. circuits are helping to remove these defects and these tests confirm that the grey scale rendition is very good. A photograph of a field sawtooth which has been converted from 525/60 to 625/50 is shown in Fig. 3.

4.3. Resolution

As operated in Rome the equalization prior to the display was reduced in order to avoid further degradation of inputs having a poor signal-to-noise ratio. A simple adjustment could be made to restore the equalization, in which case the displayed picture had negligible loss. The vidicon resolution could be assessed separately using the diascope and sufficient equalization is available to ensure full modulation up to 500 lines per picture height. A 5 Mc/s low-pass filter is normally included to limit the noise.

The vertical resolution appeared to be reasonably good for this combination of cathode ray tube and camera. Spot-wobble of the display is employed to eliminate moiré patterns due to the differing line standards in the conversion process. The vertical resolution was such that moiré patterns were visible for spot-wobble amplitudes above and below the optimum setting. A photograph of part of the screen of the output monitor is shown in Fig. 4 and the resolution can be judged from the wedges of the R.A.I. test card.

4.4. Geometry

No pin-cushion coils are provided on the display and the vidicon has a conventional scanning system. In both the vidicon and the display only small angles of deflection are employed and, this probably accounts for the remarkably good geometry of the converted picture.

Throughout the tests the operating mode was changed many times in order to carry out conversions between different line and field rates. In each case the adjustments required were small, and the change-over was made very quickly. At no time was it necessary to re-adjust the linearity controls.

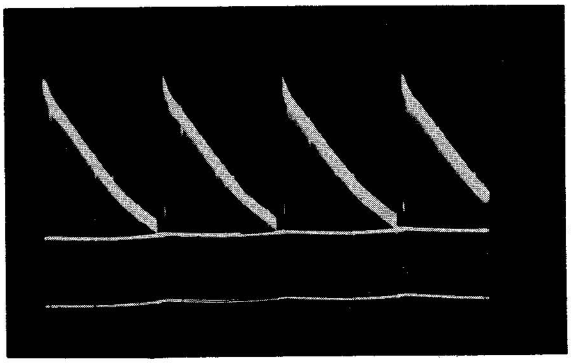

Fig. 3 - Photograph of converted field-sawtooth waveform

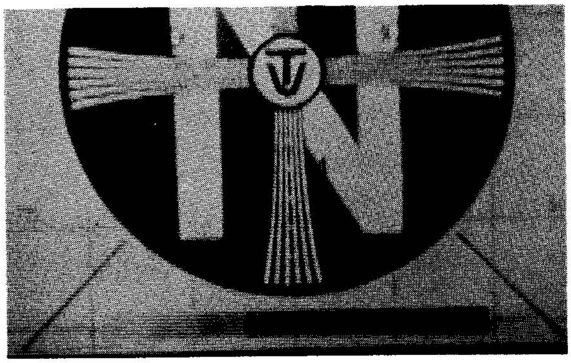

Fig. 4 - Photograph of part of R.A.I. test card after conversion

4.5. Conversion Flicker

The flicker correction system in the Fernseh converter is basically the same as that used in the B.B.C. machines. The reference stripe is on the left-hand side of the display and the a.g.c. loop-gain is about 40 with an active time-constant of about 1·5 ms. The a.g.c. is operative from zero frequency to about 400 c/s.

The basic flicker of the vidicon converter is lower than that of the C.P.S. Emitron converter; the measured figures being 8% for a 50-60 f.p.s. and 6% for a 60-50 f.p.s. conversion where % flicker is given by max-min/mean. The target illumination of the Rome converter may have been somewhat lower than that used by the manufacturers since they quote higher figures for the basic flicker modulation. This is referred to in Section 5 of this report which deals with the discussions in Darmstadt.

The basic flicker is reduced by the a.g.c. system to between 1 and 1·5% under good operating conditions and this performance is maintained when the input and output field frequencies are not related in a precise 5:6 ratio. The residual flicker is uniformly distributed over most of the picture area with a slight tendency to greater flicker in the upper half of the picture. No flicker is detectable at grey levels corresponding to the top of the reference pulse (70% of peak white) or at black level. There is no emphasis of the residual flicker around the periphery of the picture and the adjustment of the normal display and camera controls is not critical in this respect.

The outgoing picture was remarkably free of the horizontal streaks which are often associated with flicker correction systems using a reference stripe.

4.6. Portrayal of Moving Objects

An indication that the portrayal of moving objects would be poor is given by the good flicker performance, since in general this conflicts with good movement portrayal. In fact the blurring of moving objects was the most disappointing feature of the whole converter.

Fig. 5 shows curves provided by Image Scanning Section of Research Department who will shortly be issuing a report on lag in various types of camera tube. In this graph curve (a) shows the lag of a vidicon operating under the same conditions as that in the converter in Rome. Curve (b) indicates the reduction in lag which could be achieved by increasing the lens aperture to about f/1·4, which is near the limit of both lens design and vidicon performance. Curves (c) and (d) show the lag of image orthicons and C.P.S. Emitrons respectively.

Live pictures from a local studio were viewed for some time and the blurring of moving objects was somewhat disturbing. The blurring of movement was great enough to remove any sign of "judder" when viewing conversions between systems having different field frequencies.

It is noteworthy that the first model of the converter, seen during the earlier visit to Rome, appeared to portray movement somewhat better; it also gave a basic flicker modulation (with correction switched off) about twice that of the R.A.I. converter. One possible explanation is that a specially-selected or experi-

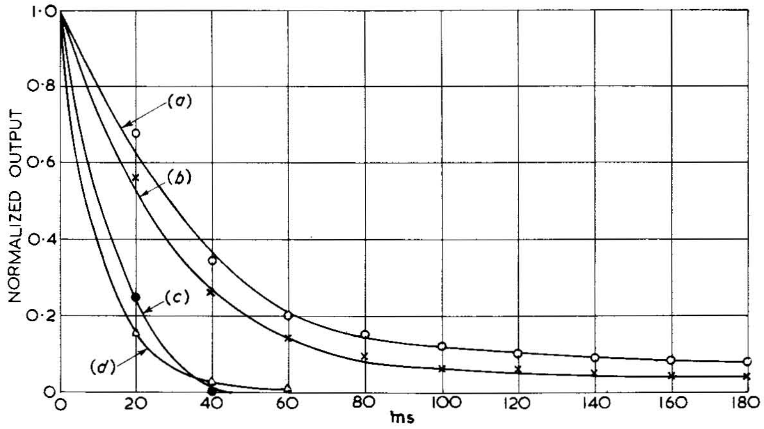

Fig. 5 - Graphs of camera tube "lag":- vidicon, C.P.S. Emitron and image-orthicon

(*a*) Vidicon 25 ft.C
(*b*) Vidicon 220 ft.C
Target volts = 11·0 V
(*c*) 4½" I.O.
(*d*) C.P.S.

mental tube was in use at that time. It is of interest to note that gamma-correction arrangements were included in the first model of the converter[2] which differs significantly from the converter of Fig. 2.

Objective results were obtained by using the "oscillating stripe" which had been pre-recorded in London; this test uses a narrow vertical stripe which is cyclically displaced in the horizontal direction. The frequency of this displacement varied between 1 and 3 c/s and the amplitude of the peak-to-peak displacement was about one quarter of the active line length. Fig. 6(a) shows a photograph of the output waveform from the converter taken while the stripe was oscillating at a frequency of 3 c/s. This photograph shows at least five images of the single vertical stripe, while Fig. 6(b) taken from a C.P.S. Emitron converter shows only three images.

The portrayal of moving objects is referred to again in the Section of this report which deals with the discussions in Darmstadt.

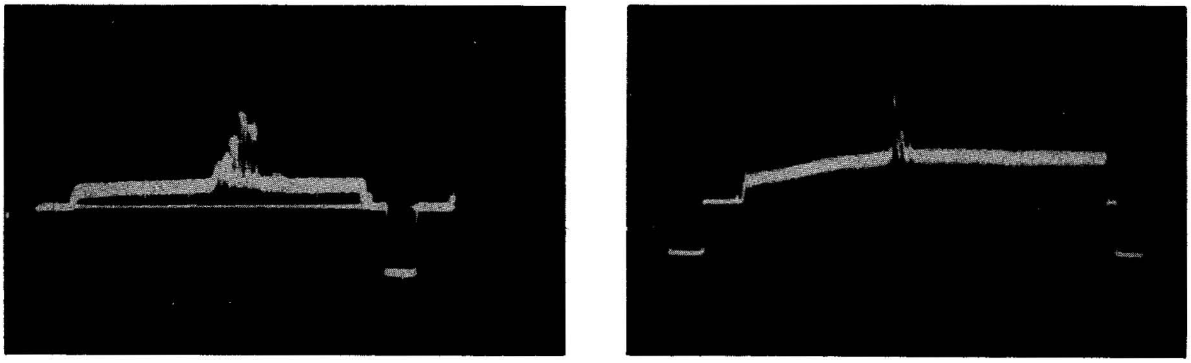

Fig. 6 - Photographs of waveform resulting from conversion of oscillating stripe

(*a*) Fernseh converter (*b*) B.B.C. converter

6. CONCLUSIONS

The Fernseh standards converter is extremely well designed and constructed and represents good value for money. It can be satisfactorily operated by relatively unskilled staff and includes many refinements and facilities to simplify routine alignment. Circuit stability is high and the reliability should be very good.

As far as picture quality is concerned the resolution, grey-scale, geometry and residual flicker match the best performance of the Research Department converters while the signal-to-noise ratio is undoubtedly better.

The one contentious feature is the lag inherent in all present day vidicons and curve (b) of Fig. 5 represents the minimum lag which can be obtained. For conversions between European standards and the American standard a good balance of performance is obtained from a vidicon camera since the lag contributes to good flicker performance and the elimination of 10 c/s judder from rapid motion. However, for conversions between systems having field frequencies less than 1 c/s apart the lag of the vidicon is wholly disadvantageous. For such applications the choice of standards converter must be decided by weighing the Fernseh's excellent design and superior performance with static pictures, against the better movement portrayal of other types of converter.

The fact that the first model of the converter gave a better portrayal of motion might suggest that a better performance could be obtained, either by different operating conditions or by a different or specially-selected vidicon tube. Nevertheless, in view of the fact that Dr. Dillenburger could not hold out much hope of improvement (save by using a Plumbicon), it is felt that practical decisions should be based on the performance of the R.A.I. converter described in this report.

Although a decision to purchase another type of commercial standards converter and not to use Fernseh converters would make it necessary to provide higher grade operators in a standards conversion area, this would appear worth while since good movement portrayal is very important if long periods of 625 to 405 conversion are envisaged.

7. ACKNOWLEDGEMENT

The authors wish to express their gratitude to members of the staff of R.A.I. for their help and co-operation, and in particular to Dr. Riccomi and Signor Zaccarian who did everything possible to make the visit a success.

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